1.3 Statics - Forces in Equilibrium

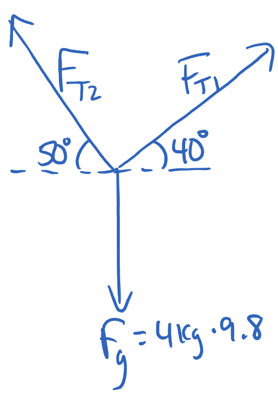
September 14, 2017 10:32 AM

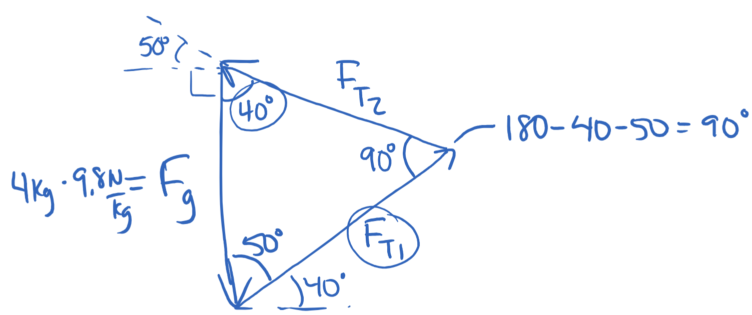
1st condition of static equilibrium:

- all forces must add to zero $\sum \vec{F} = 0$ (← sum of)
- all components must add to zero

$$\sum \vec{F}_x = 0 \quad , \quad \sum \vec{F}_y = 0$$

Example pg 25 - done the component way, but an easier way is to use equilibrium Δ.





$$\frac{F_{T1}}{\sin 40°} = \frac{4 \cdot 9.8}{\sin 90°} \qquad \frac{F_{T2}}{\sin 50°} = \frac{(4 \cdot 9.8)N}{\sin 90°}$$

($\sin 90° = 1$)

$F_{T1} = 25.2\,N$ $\qquad$ $F_{T2} = 30.0\,N$

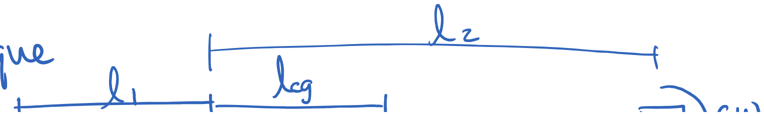
Practice pg 26 #1-3

2nd condition for static equilibrium: "Rotational Equilibrium"

$$\tau = \vec{F}_{\perp} l = \vec{F} l \sin\Theta \qquad [N \cdot m]$$

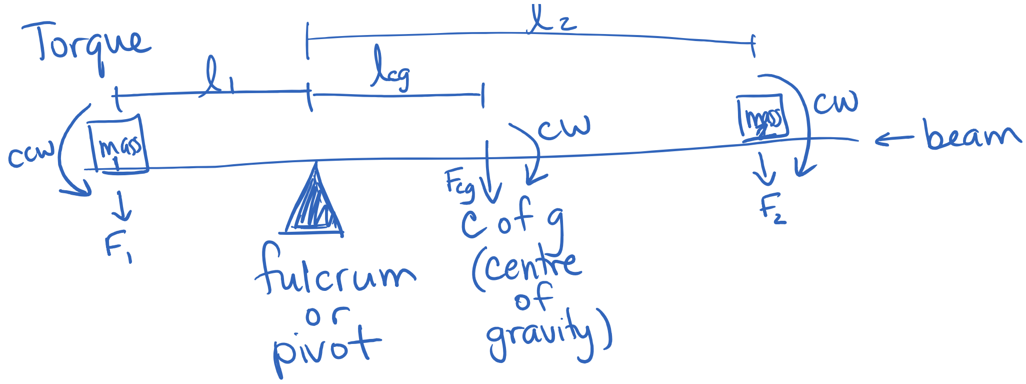
↑ Torque

Force and length are always ⊥ for τ



always for τ

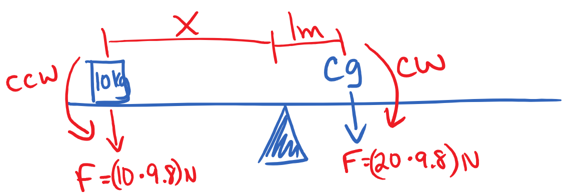
measure lengths from fulcrum



$$\sum \tau_{cw} = \sum \tau_{ccw}$$ ← yeild no rotation → in equilibrium

$$F_{cg} \cdot l_{cg} + F_2 \cdot l_2 = F_1 \cdot l_1$$

Ex



- mass of a 10 m beam is 20kg
- How far is the 10kg mass from the pivot if pivot is 1m to left of the c of g?

$$\tau_{ccw} = \tau_{cw}$$

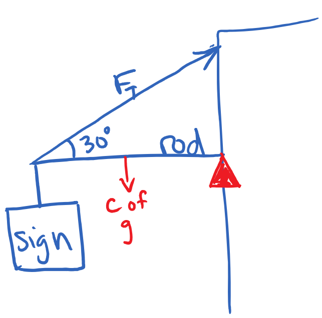
$$(10 \cdot 9.8N)(x) = (20 \cdot 9.8N)(1m)$$

x = 2 m to left of fulcrum

pg 28 #1-2, try #3

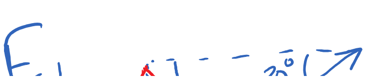
Example Torques with angles

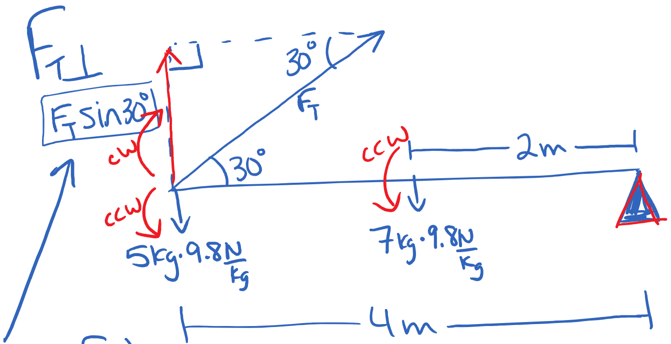
Tension in rope = ?
sign = 5 kg
rod = 7kg, 4m



✡ don't forget c of g

✡ locate pivot at a convenient place
- where Force is indicated or being looked for
- usually one end or the other





- usually one end or the other

☆ use the perpendicular component of force

$$\sin 30° = \frac{F_{T\perp}}{F_T}$$

$$F_{T\perp} = F_T \sin 30°$$

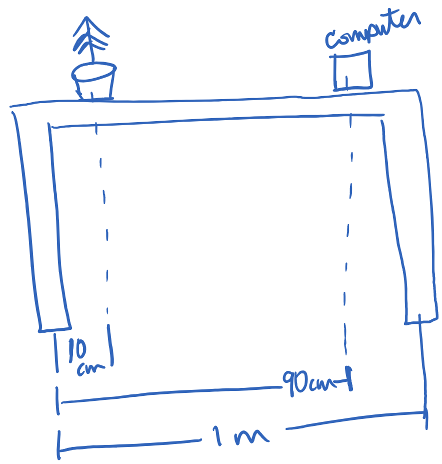
$$\tau_{cw} = \tau_{ccw}$$

$$\underbrace{(F_T \sin 30°)}_{F_\perp}(4m) = \underbrace{(5 \cdot 9.8)(4m)}_{\text{sign}} + \underbrace{(7 \cdot 9.8)(2m)}_{\text{c of g}}$$

$$F_T = 167\,N$$

Example: Table

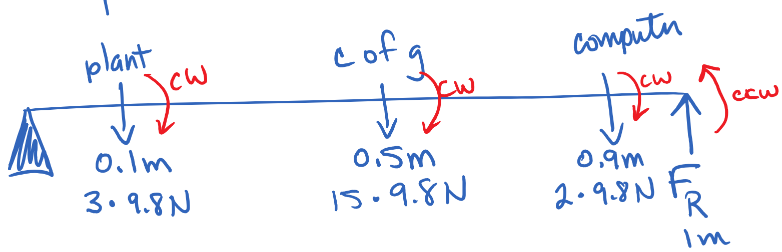
Table = 15kg
plant = 3kg
computer = 2kg



What is the upward force exerted by each leg?

Do as 2 problems

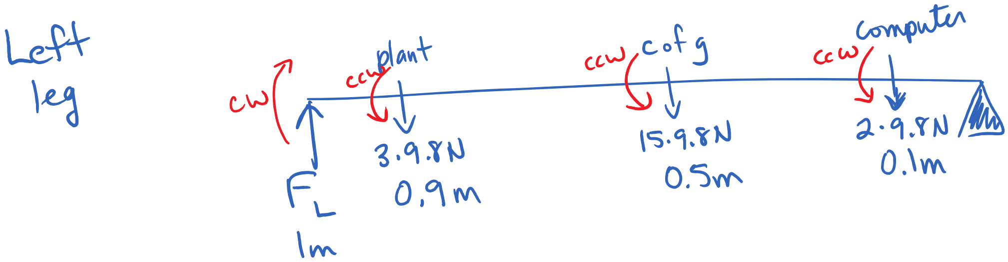
Right leg



$$\tau_{cw} = \tau_{ccw}$$

$$\underbrace{(3 \cdot 9.8N)(0.1m)}_{\text{plant}} + \underbrace{(15 \cdot 9.8N)(0.5m)}_{\text{table}} + \underbrace{(2 \cdot 9.8N)(0.9m)}_{\text{computer}} = F_R(1m)$$

$F_R = 94\text{ N}$



$$\tau_{cw} = \tau_{ccw}$$

$$F_L(1\text{m}) = (3\cdot 9.8\text{N})(0.9\text{m}) + (15\cdot 9.8\text{N})(0.5\text{m}) + (2\cdot 9.8\text{N})(0.1\text{m})$$

$$F_L = 102\text{ N}$$

- ✱ slightly more support needed near heavier plant
- ✱ Total weight of Table, plant and computer $= (15+3+2)9.8 = \underline{196\text{N}}$
  = the total that the legs are supporting
  $94 + 102 = \underline{196\text{N}}$

1.3 Review pg 33 #1-5

Ch 1 Review pg 34 #1-19
└ do at least to #10